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no. 26

NEW SOUTH WALES.

DEPARTMENT OF MINES.

GEOLOGICAL SURVEY.

J. E. CARNE, F.G.S., Government Geologist.

MINERAL RESOURCES.

No. 26.

FELSPAR IN NEW SOUTH WALES.

BY

L. F. HARPER, F.G.S.,
Geological Surveyor.

Issued by direction of the Honorable J. C. L. Fitzpatrick, M.L.A.,
Minister for Mines.

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† 1106—A

LETTER OF TRANSMITTAL.

Geological Survey Branch,
Department of Mines,
Sydney, 25th July, 1917.

Sir,

I have the honor to submit for publication No. 26 of the Mineral Resources Series dealing with the occurrence of Felspar in New South Wales. This note has been prepared by Mr. L. F. Harper, F.G.S., Geological Surveyor.

Felspar is used principally in various branches of the pottery and ceramic industries, and has hitherto been to a great extent imported.

It is possible that owing to the practical impossibility of obtaining foreign supplies, the opportunity may arise of developing local deposits, and the object of Mr. Harper's report is to direct attention to deposits in the State which have up to the present been examined.

I have the honor to be,
Sir,
Your obedient Servant,
JOSEPH E. CARNE,
Government Geologist.

The Under Secretary for Mines.

Felspar in New South Wales.

INTRODUCTION.

Hitherto practically all the felspar used in New South Wales has been imported; but owing to existing conditions as regards oversea freightage, its importation has become practically prohibitive, and consumers are now forced to look round for a local supply.

Certainly the present demand probably does not exceed 100 tons per annum, but there are many imported articles for the manufacture of which felspar is necessary, and there appears no reason why local industries should not be established for their manufacture.

Felspar mining, treatment, and uses are very little understood in New South Wales, and the object of this report is to review the whole question, and bring the mineral under the notice of the prospector with a view to the location of payable deposits. It is also desired to supply the commercial world with such particulars as may assist in establishing both a supply and a demand, in order that New South Wales may be independent of imported ground felspar and many of the finished articles for which its use is essential.

Up to the time of writing this report, only five deposits* have come under the writer's notice, but this may be due to the fact that hitherto there has been no demand for local felspar, and the prospector has not paid any attention to its occurrence.

There appears no reason why extensive deposits of felspar should not be found in New South Wales, for geological conditions are favourable over many areas of granite country within the State.

The time is undoubtedly opportune for the development of the industry, for it is likely to be protected to the extent of prohibitive importation freights for some time to come, thus enabling initial costs to be met and other preliminary difficulties to be overcome before competition from outside sources has to be faced.

A word of advice may be tendered to prospectors as to the value of this material, in order that an exaggerated idea be not entertained as to its value. Felspar is used in the ceramic arts, particularly for porcelainising, and before the finished article is placed on the market the raw material has to pass through numerous processes, so that it will not carry a great initial cost.

The advantages of a good deposit of felspar, convenient to market, are the low mining costs and the tonnage likely to be disposed of annually if the price is reasonable. As an example, it may be pointed out that in 1915, the United States of America produced 113,769 short tons of felspar, valued at about 22s. per ton, and whilst nothing like that tonnage would be utilised in New South Wales, still the price paid would be higher, if only to the extent of freight costs.

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* See page 9

A table of the world's production of felspar recently published* is as follows :—

FELSPAR sold in principal producing countries, 1911–1915.

	1911.		1912.		1913.		1914.		1915.	
	Quantity (short tons).	Value (dollars).	Quantity (short tons).	Value (dollars).	Quantity (short tons).	Value (dollars).	Quantity (short tons).	Value (dollars).	Quantity (short tons).	Value (dollars).
United States	92,700	579,008	86,572	520,562	120,955	776,551	135,419	629,873	113,769	629,356
Belgium (a)	....	1,655	....	660	(b)	(b)	(b)	(b)	(b)	(b)
Canada (c)........	17,723	51,939	13,733	30,916	15,935	56,841	18,060	70,824	15,455	59,124
Germany (a)...... (Bavaria)	3,489	13,689	7,348	49,581	(b)	(b)	(b)	(b)	(b)	(b)
Italy (d)..........	39,417	44,585	37,416	44,079	35,569	39,172	35,863	43,305	(b)	(b)
Madagascar (a) ..	....	....	451	....	(b)	(b)	(b)	(b)	(b)	(b)
Norway (e) (a)	38,429	124,096	43,919	146,325	(b)	(b)	(b)	(b)	(b)	(b)
Sweden (a)	39,942	89,743	37,814	88,682	(b)	(b)	(b)	(b)	(b)	(b)

(a) Statistics taken from Mines and Quarries, Gen. Report and Statistics. Pt. 4, London.

(b) Statistics not available.

(c) Reports on Mineral Production of Canada : Canada Dept. of Mines.

(d) Includes quartz ; statistics taken from Rivista del Servizio Minerario, Rome.

(e) Export figures.

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*"Felspar in 1915." By Frank J. Katz, Dept. of Interior, U.S. Geol. Survey, Min. Resources, U.S.A., 1915. II. (7.), Washington, 1916, page 53.

Department of Mines
Sydney

With the Compliments
of
The Under Secretary,
Department of Mines,
Sydney, N.S.W.,
Australia

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ACKNOWLEDGMENTS.

The writer is greatly indebted to the works of Frank J. Katz*, A. S. Watts,† and Hugh S. de Schmid, M.E.,‡ for much of the information contained in this pamphlet, and these authors have been quoted from freely.

Mr. A. P. J. McGauran, Sydney Agent for the Nambucca felspar deposit, has been of great assistance with regard to local information concerning the occurrence of felspar in New South Wales, and the market possibilities.

VARIETIES OF FELSPAR.

According to Mr. Katz, "Common felspars are crystalline compounds of silica, alumina, and one or more of the bases, potash, soda, and lime. There are two principal classes of felspar—the one including the potash and potash-soda varieties, the other including the soda, soda-lime, and lime varieties." The mineralogical names of the pure potash felspars are Orthoclase and Microcline, and both are alike in their chemical composition and physical properties, so that commercially they may be considered identical. The theoretical composition of both is silica 64·7 per cent,, alumina 18·4 per cent., potash 16·9 per cent.

Albite is the pure soda variety, with the following composition:—Silica, 68·7 per cent.; alumina, 19·5 per cent; soda, 11·8 per cent. It is rare, however, that the theoretical standard is maintained, and the alkalies occur in varying proportions. One essential from a commercial point of view is the total proportion of lime admissible.

Felspars are among the most widely distributed minerals, and occur in nearly all igneous rocks. As a rule, however, the grain is small, and they are so closely associated with other minerals as to be of no commercial importance.

Coarse-grained granites, known as pegmatites, are practically the sole source of the world's felspar supplies, and these generally occur as dykes or irregular-shaped masses, from which the coarse crystalline and comparatively pure felspar may be won by hand-picking. The mode of occurrence renders it difficult to predict the extent of any given deposit, as they are most frequently lens-shaped, and the proportion of felspar present must of necessity be an unknown quantity prior to working. It is common for the lenses when occurring in granite or other massive rock to follow more or less parallel fractures, so that prospecting should be carried out with this in view.

The following minerals are most commonly associated with the felspar in pegmatite:—Quartz, muscovite or white mica, and biotite or black mica, with lesser quantities of tourmaline, garnet, magnetite, and iron pyrites, the latter occurring as small scattered crystals or miniature bunches of crystals.

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* "Felspar in 1915." By Frank J. Katz. Dept. of Interior, U.S. Geol. Survey, Min. Resources, U.S.A., 1915, II. (7): Washington, 1916.

† "Mining and Treatment of Felspar and Kaolin in the S. Appalachian Region." Dept. of Interior U.S. Geol. Survey, Bulletin 53, Min. Tech. I.: Washington, 1913.

‡ "Felspar in Canada." Canada, Department of Mines: Ottawa, 1916.

Mining and Milling.

The methods adopted in mining a felspar deposit are very simple, and consist of an open cut, by which means costs are reduced to a minimum, for it is possible to avoid mining valueless portions of the deposit. If the occurrence is on a hillside, a graded track should be cut into the floor of the quarry, and, if the output justifies it, two light lines of rails laid, one for trucking out the hand-picked felspar and the other for removing quarry refuse.

After the material has been hand-cobbed and picked, the method of grinding felspar in America, according to Mr. F. J. Katz*, is as follows :—"The methods used for grinding felspar for pottery and enamel ware are similar in a general way in all the Eastern States. Some spar is first burned in kilns, which serves to fracture it and thus facilitate grinding. Most felspar, however, is fed, just as it comes from the quarry, into chaser mills. The material from the chasers is screened, the tailings being returned for recrushing, and the fines going to the tube mills for fine grinding.

" For use in pottery it is so ground, as screen tests on commercial pottery spar have shown that 99·3 to 99·8 per cent. passes through a 100-mesh screen, and 96·7 to 98·2 per cent. through a 200-mesh screen. Some felspar prepared for use in abrasive soaps is even more thoroughly ground to reduce it to extreme and uniform fineness."

Only a very small quantity of felspar has hitherto been prepared in New South Wales, and considerable difficulty appears to have been experienced in turning out a satisfactory article. One method of treatment adopted here was to pass the crude material through a rock-breaker, and feed to a Krupp ball mill. Very fine pulverisation is thus secured, but the product is found to contain quite an appreciable quantity of metallic iron. This is a most objectionable feature when the felspar is used for ceramic purposes, and a pure white glaze is essential. Experiments are now being conducted with a view to extracting the iron by means of an electro-magnet, and although it adds to costs, the results appear to be very satisfactory. On the other hand, the grinder raises objections to treating the material owing to the wear and tear on his plant, and naturally his charges are proportionately high.

Another method of treatment adopted has been to have the felspar ground in a buhrstone mill. This appears to have been far from satisfactory from all points of view, for not only was the finished product of a decided cream colour owing to the addition of a large proportion of pulverised buhrstone, but the wear and tear on the latter was disastrous. Certainly the trouble may be largely due to inferior buhrstones, which by wearing away would both adulterate and discolour the ground felspar.

As far as can be ascertained this method of treatment is generally adopted in America with satisfactory results, and the fine material is fed to ball mills. These, according to Mr. A. S. Watts,† " are steel-barrel tumbler mills 6 to 7 feet long, and of about the same diameter. They are lined with hard wood or silica blocks and are charged with French flint pebbles 2 to 3 inches in diameter. The revolving of the mill causes the pebbles to roll or slide, thus pulverising the felspar."

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* " Felspar in 1915." By Frank J. Katz. Min. Resources of the United States, 1915. Part II, p. 47.

† " Mining and Treatment of Felspar and Kaolin," p. 65, Bulletin 53, Mineral Technology I. Dept. of the Interior, Bureau of Mines, Washington.

In view of the troubles experienced by local grinders of felspar, the suggestion is made that before grinding, heating and quenching be tried, particularly when a hard variety has to be dealt with. This should reduce the wear and tear on the plant, but it must be borne in mind that potash felspars begin to soften at 1150° C., so that excessive temperatures must be avoided.

Quality.

The quality of felspar from a ceramic point of view is dependent to a very great extent upon colour. According to A. S. Watts,* a high grade felspar is obtained from Maine, U.S.A., the colour of which has been accepted as a standard. The analysis of this felspar is as follows :—

Chemical Analysis of standard Maine Felspar.

(Analysis by Ohio Geological Survey.)

Silica (SiO_2)	71·75
Alumina (Al_2O_3)	16·70
Ferric oxide (Fe_2O_3)	·14
Titanium dioxide (TiO_2)	·03
Lime (CaO)	·25
Magnesia (MgO)	......
Loss on ignition	·35
Potash (K_2O)	8·59
Soda (Na_2O)	2·99
	100·80

It will be seen that the iron contents in the above "standard colour" felspar is ·14, and on comparing analysis of the Nambucca River and Hartley deposits, we find even a lower iron percentage. (*See* pp. 9-13.)

When it is recognised that discoloration in ceramic glazes or enamels is due almost entirely to iron contents in the mixture used, it is self-apparent that the deposits mentioned should provide a material giving high grade results.

The felspar deposits which have come under the notice of the writer all contain a very small percentage of iron pyrites, but there is every reason to believe that by careful hand-picking, a large proportion of the pyrites could be eliminated.

Other iron-bearing minerals such as biotite (black mica), garnet, or tourmaline, if present in sufficient quantity, have a deleterious effect upon the colour of the ground felspar, and care should be taken to reject as much as possible of the material containing these minerals.

Other Impurities.

An excessive percentage of quartz (less than 20 per cent. is desirable in the ground product) is a drawback to felspar for use in the ceramic arts, as it affects the fusibility; but in cases where there is an intimate intergrowth of quartz and felspar incapable of economic hand-picking, the difficulty may be overcome if a sufficient quantity of pure felspar is added.

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* *Ibid.*, p. 25.

Mr. F. J. Katz* points out that "The requirements of the potter's trade demand that in general the percentage of free quartz associated with the felspar used for this purpose shall not exceed 20 per cent. in the ground product, and certain potters demand a spar which is nearly pure, containing probably less than 5 per cent. of free quartz. In order to be profitably worked, in most felspar mines between one-fourth and one-half of the total material that must be excavated should contain less than 20 per cent. of free quartz."

According to the same authority, "The presence here and there of minute flakes of white mica (muscovite) is characteristic even of the highest grades of commercial felspar, and chemically this mineral is not injurious. It is, however, exceedingly difficult to pulverise the thin, flexible mica plates to a fineness equal to that required in the felspar, and it is therefore necessary in mining to separate carefully as much of the muscovite as possible from the spar.

Uses.

Felspar is used principally in the manufacture of pottery, enamelware, porcelain, chinaware, for enamel bricks and tiles, and in the various grades of ceramic products.

A limited amount is utilised in abrasive soaps, particularly those used for window cleaning, and also for bonding purposes in the manufacture of emery and carborundum wheels.

A comparatively few tons of selected high grade potash felspar are used in the manufacture of artificial teeth.

According to Mr. de Schmid†, the question of extracting potash from felspar has received considerable attention within the past few years, but he states that "there is no evidence to show that any of the suggested processes can be considered commercially practicable, the cost of extraction being prohibitive." The same writer refers to recent attempts to place on the market finely-ground potash spar as a fertiliser, but here, again, the results do not appear to support the claims made for it.

When close to a market and easily won, low-grade felspar may be employed as poultry grit with advantage, coarse grinding being the only necessary preparation.

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* *Ibid.*, pp. 45, 46.

† "Felspar in Canada." Dept. Mines, Canada: Ottawa, 1916, p. 97.

NEW SOUTH WALES' DEPOSITS.

Up to the present the known deposits of felspar of any extent in New South Wales which have come under the notice of the writer are as follows, but it may be that others will be located now that the attention of the prospector and manufacturer has been directed to its uses and commercial possibilities.

The following deposits of felspar are described in detail:—

1. Within portion 16, parish of Valley Valley, county Raleigh, about 8½ miles by road north-west of Nambucca Harbour.
2. Near portion 282, parish of Lett, county of Cook, 2 miles north-east from the village of Hartley, and 5 miles from Lithgow railway station.
3. In the parish of Bodangora, county Lincoln, between the 16 and 17-mile posts (from Wellington), on the Wellington-Mudgee road.
4. Barrier Ranges, between Purnamoota and Waukeroo, and in the neighbourhood of Euriowie, 40 miles north of Broken Hill.
5. In the parish of Moonbi, county of Inglis, 3½ miles west of Kootingal Railway Station, 295 miles north of Sydney.

Detailed Descriptions.

No. 1.—Near Nambucca.

The syndicate holding this deposit is devoting considerable energy to establishing a market for their product, and there appears no reason why their enterprise should not eventually meet with success.

Mr. W. J. Hammond, of Bellingen, one of the principals, may be credited with being the pioneer of the felspar industry in New South Wales, and it was through him that felspar was proclaimed a mineral under the Mining Act.

Mr. A. P. J. McGauran, of 33 Rowe-street, Sydney, is the representative of the syndicate, and is doing much by his energy and enthusiasm to create a market for locally-produced felspar.

The deposit is situated on private land, about 2½ miles west of the main road from Nambucca to Bellingen, and is 8½ miles from the former, to which the felspar is carted and shipped to Sydney.

The geological formations in this neighbourhood consist of slates of Silurian age, which have been intruded by a mass of granite containing pipes of pegmatite. Several pipes were examined, in some of which felspar predominates, and in others quartz, and as these occur near the top of a range of steep hills, quarrying facilities are good.

Up to the present, only one pipe has been opened up, the apparent surface dimensions of which are 60 feet long by 30 feet wide. The quarry is about 12 feet in diameter, and has a maximum depth of 4 feet, running out to nothing on the down-hill side.

The felspar occurs in masses, is crystalline, milky-white in colour, and comparatively undecomposed, even at the grass roots. Occasional small blebs of quartz occur in the spar, also localised specks of iron pyrites and muscovite (white mica), whilst joint faces are slightly stained with iron oxide. Blocks of practically pure felspar up to 3 feet in diameter are being shot out, which, on breaking to a size suitable for bagging, require very little hand-cobbing to eliminate impurities.

Pockets of pure quartz occur interspersed with the felspar masses, also irregular-shaped patches of aplitic granite, and at times considerable hand-picking is necessary to ensure only a first-grade product being bagged. Judging by the work done, not less than 50 per cent. of the deposit consists of high-grade felspar, and an estimate of the quantity available has been based upon this assumption, although it is admittedly conservative under existing appearances. In other pipes and lenses of pegmatite in this neighbourhood examined by the writer, quartz or aplitic granite predominated over the pure felspar, but it may be that, if sunk on, payable deposits of pure felspar would be disclosed. Similar conditions may pertain throughout all the pipes, at different levels, and possibly at no great depth beneath the surface the main characteristics of each pipe will vary, so that prospecting should not be confined to any one outcrop.

With regard to the impurities in this felspar, it appears probable that if reasonable care be exercised in mining and bagging, no great amount of hand-picking or cobbing will be necessary to insure a first-grade marketable product. Care should be exercised to eliminate the pieces containing an undue proportion of quartz, excessively iron-stained fragments, or pieces with " nests " of iron pyrites.

As an illustration of the quality of the first-grade article from this deposit, the following analysis, made in the laboratory of the Department of Mines, may be quoted :—

2639–16.

Silica (SiO_2)	64·40
Alumina (Al_2O_3)	19·98
Ferrous and Ferric oxide $\left\{\begin{matrix}Fe_2O_3\\FeO\end{matrix}\right\}$	0·05
Magnesia (MgO)	absent
Lime (CaO)	0·26
Soda (Na_2O)	2·85
Potash (K_2O)	11·99
Total moisture (H_2O)	0·48
Titanium dioxide (TiO_2)	absent
Manganous oxide (MnO)	*trace
Barium oxide (BaO)	*trace
Lithium oxide (Li_2O)	nil
	100·01

Comparing the above with an analysis of "a high-grade felspar," given on page 7, it will be seen that the Nambucca felspar can, on chemical analysis, claim to be of a high-grade quality.

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* Less than 0·01 per cent.

Associated with the felspar and quartz in the pipes is a milky-white granite (aplite) composed mainly of medium-grained crystalline quartz and felspar, with occasional small nests of iron pyrites. An analysis of this rock indicates the following general composition :—

Analysis of "country rock," Nambucca felspar deposit.

Silica (SiO_2)	76·50
*Alumina (Al_2O_3)	12·24
Ferric oxide (Fe_2O_3)	0·50
Ferrous oxide (FeO)	0·56
Soda (Na_2O)	3·43
Potash (K_2O)	3·94

This composition approaches that of Cornish stone, largely used in the manufacture of whiteware, but its hardness may be against its economic use. Until practical tests have been made, however, it is not possible to express an opinion as to its utility in the ceramic industry.

As this material has to be hand-picked from the felspar, it would be greatly in favour of economic working if a market could be found for it.

An attempt to estimate the quantity of commercial felspar in this neighbourhood is somewhat premature owing to the very limited amount of prospecting work carried out up to the present. Quantities will depend almost entirely upon two factors, namely, the vertical dimensions of the pipes, and the predominating mineral therein. As pointed out, some of the outcrops show an excessive amount of quartz, whilst in the deposit being worked felspar predominates.

It is more than probable, however, that the relative proportions of these minerals will vary at different depths in the individual pipes, and one which is not workable at the outcrop may greatly improve if sunk on for a few feet, or *vice versa*.

Assuming that about 50 per cent. of the deposit being worked will be marketable, and allowing a depth of 50 feet, it is reasonable to assume that not less than 3,000 or 4,000 tons of felspar will be available.

DEPOSIT NO. 2.—NEAR HARTLEY.

This deposit is about half a mile off the main road from Mount Victoria to Lithgow, and less than 5 miles from the railway at the latter town.

The deposit is on Crown land, and Messrs. Basser and Morris have an application pending for a mineral lease to cover the deposit.

The geological formations to the north and east of the deposit consist of sandstones and conglomerates of Upper Marine age. These beds rest on an extensive mass of granite, which crops out to the west of the Lithgow road, and contains the felspar deposit.

An open cut some 60 feet long by 20 feet wide has been sunk to a depth of about 6 feet, exposing a more or less lens-shaped mass of quartz and felspar. The deposit does not appear to be confined between strict walls, for in places large bunches of felspar and quartz extend beyond the apparent walls, whilst in others there is a well defined line of demarcation. The strike of the deposit is approximately S. 10° E., and it appears to gradually pinch out at either extremity, until normal granite only is visible.

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* Contains traces of phosphoric anhydride and titanium dioxide.

The felspar is crystalline, and occurs in bunches up to 4 feet in diameter in which blebs of quartz of various sizes are noticeable, with occasional quartz-crystals up to 2 inches in diameter. Large masses of amorphous silica occur, also patches of coarse grained granite in which felspar predominates.

Only one deposit was seen by the writer, but further prospecting should reveal others, and quartz exposures are likely to pass downwards into workable deposits of felspar.

Nature of the Felspar.

The felspar is very slightly kaolinised, and contains occasional small blebs of quartz, but no mica or other mineral was observed. On some of the faces slight iron-staining occurs, but the greater portion of the material is of a pure milky-white colour.

The following analysis, made in the laboratory of the Department of Mines, indicates the quality of the hand-picked spar:—

ANALYSIS of Felspar from near Hartley.

Silica (SiO_2)	65·52
Alumina (Al_2O_3)	20·14
Iron oxide	0·10
Magnesia (MgO)	......
Lime (CaO)	......
Soda (Na_2O)	3·49
Potash (K_2O)	9·88
Moisture	......
Titanium dioxide (TiO_2)	nil
Phosphoric anhydride (P_2O_5)	trace

As the foregoing analysis indicates, this felspar is comparatively free from impurities, and by discriminate hand-picking it should be possible to procure a high-grade product.

The associated granite may have some value as Cornish stone, and the prospectors are advised to submit samples to firms interested in the ceramic industry.

The evidence available, and known modes of occurrence of such deposits, render it difficult to form an estimate of the quantity available. Probably not more than 30 per cent. of the material showing in the present quarry would pay to bag, and if the deposit extends to a depth of only 40 feet, which may or may not prove conservative, it is estimated that from 750 to 1,000 tons of felspar could be obtained from the deposit under review.

Further prospecting in the neighbourhood is advocated, however, in the hopes of augmenting the supply, for its proximity to a market is a favourable factor in economic working.

DEPOSIT NO. 3.—ON THE WELLINGTON-MUDGEE ROAD.

This occurrence is well seen on the main road from Wellington to Mudgee, the best exposures being in the road cutting between the 16 and 17 mile posts.

The felspars occur as porphyritic crystals up to 2 inches in length, and so thick are they in this particular spot that hundreds of tons could be collected without hand-picking.

The granite mass in which they occur occupies an area of over 50 square miles, but as far as the writer is aware, the coarsely porphyritic type is very localised.

The accompanying analysis has been made in the departmental laboratory —

Silica (SiO_2)	65·10
Alumina (Al_2O_3)	18·69
Ferric oxide (Fe_2O_3)	0·60
Ferrous oxide (FeO)	0·18
Magnesia (MgO)	0·08
Lime (CaO)	0·44
Soda (Na_2O)	2·79
Potash (K_2O)	10·61
Combined moisture (H_2O+)	0·58
Included moisture (H_2O-)	0·12
Titanium dioxide (TiO_2)	0·25
Zirconium dioxide (ZrO_2)	nil
Phosphoric anhydride (P_2O_5)	trace [*]
Vanadic oxide (V_2O_5)	nil
Sulphur trioxide (SO_3)	0·02
Chlorine (Cl)	nil
Manganese oxide (MnO)	0·04
Barium oxide (BaO)	0·78
	100·28

The crystals vary in colour on the surface from a dirty brown to a pale red, and on breaking are found to have a decided yellowish tint. This is due to the percentage of iron present, which is higher than in the felspar from Deposits 1 and 2.

The distance of this deposit from rail and a market would be a big drawback to economic handling, even if the quality were really high grade; moreover, the mode of occurrence is unfavourable to cheap winning once the surface accumulations have been removed.

The occurrence is interesting from a scientific point of view, but there appears little prospect of it becoming of economic importance.

No. 4.—The Barrier Range Deposits.

This group of deposits is situated from 30 to 40 miles north of Broken Hill, and has not been visited by the writer, but the following information is extracted from a work by Mr. J. B. Jaquet, A.R.S.M., F.G.S.,[†] Chief Inspector of Mines :—

"Between Purnamoota and Waukeroo you have granite hills occupying a belt of country 9 miles long by 3 miles broad. The constituent minerals are quartz, which may be massive or in the form of grains; felspar, consisting of orthoclase and plagioclase; and light mica. In the neighbourhood of Waukeroo and Euriowie, in addition to the primary minerals, tourmaline, cassiterite, and fluorspar occur. The crystals of orthoclase frequently have assumed enormous dimensions; and such crystals are occasionally associated with plates of mica, which may be of value in commerce.

"In every case the granite is very coarsely crystalline. If the outcrop of a dyke be followed along it will be found to consist in one place solely of felspar . . . ."

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[*] Less than 0·01 per cent.

[†] "Geology of the Broken Hill Lode and Barrier Ranges." Geology No. 5. Memoirs Geol. Survey, N.S.W.: Sydney, 1894, pp. 50, 51.

From the above it is apparent that there are extensive [illegible] of felspar in this region. Much of the material is pure white in colour with no impurities, and its general chemical composition is indicated by the following analysis published in 1893* :—

Moisture at 100° C.	nil
Combined water	·35
Silica	61·75
Alumina	20·74
Ferric oxide	·66
Manganous oxide	trace
Lime	·80
Magnesia	·17
Potash	14·84
Soda	1·07
Sulphuric anhydride	trace
	100·38

Although large quantities of felspar of the above quality are apparently available, its inaccessibility and distance from a market renders it of no economic importance at the present time. It is to be hoped, however, that the future expansion of the ceramic industry will not be restricted owing to an apparent lack of a local supply of felspar.

DEPOSIT NO. 5.—THREE AND A HALF MILES WEST OF KOOTINGAL RAILWAY STATION.

This deposit is situated in the parish of Moonbi, county Inglis, 3½ miles west of Kootingal, a railway station on the Northern line, 295 miles from Sydney. The writer is indebted to Mr. E. C. Andrews, B.A., F.G.S., geological surveyor, for the information regarding this occurrence, which is being prospected for scheelite and molybdenite. The felspar occurs in pegmatite veins, varying in width from 8 inches to 2 feet, the lengths of which have not yet been determined. The veins consist of felspar and cairngorm in about equal proportions, and pass here and there into an elvan.

Occasional blebs of quartz are associated with the felspar, also flakes of white mica, but iron-bearing minerals are not noticeable in the samples examined. The spar is crystallised and fresh, with a flesh-coloured tint, and on firing yields a good, white, semi-transparent glaze.

Mr. W. Betts, of Kootingal, holds a mining authority over the deposit at present, and although the quantity of spar available appears limited, its quality and proximity to the railway should prove attractive to users.

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* Annual Report, Dept. of Mines, p. 51. Sydney, 1893.

The fo[illegible]ysis, made in the Laboratory of the Department of Mines, indi[illegible]neral composition of the felspar in these deposits :—

Analysis.

Moisture at 100° C.	0·17
Water above 100° C	0·32
Silica	66·06
Alumina	18·84
Ferric oxide	absent
Ferrous oxide	0·36
Manganous oxide	0·01
Nickel and cobalt oxides	absent
Magnesia	0·08
Lime	0·18
Soda	2·57
Potash	11·70
Barium oxide	absent
Strontium oxide	......
Titanium dioxide	absent
Iron Pyrites (Fe. S_2)	absent
Phosphoric anhydride	trace
Vanadium oxide	absent
Chromium sesquioxide	absent
Sulphur trioxide	absent
Chlorine	absent
	100·29

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